

Switch-Mode DC Power Supplies

Compact, high-performance power supplies for modern manufacturing and environmental processes

L LNL is developing state-of-the-art direct current power supplies for manufacturing applications. These power supplies use pulse-width-modulated, switch-mode technology operating at approximately 20 kHz; output power ranges from several kilowatts to five hundred kilowatts.

By using pulse-width-modulated technology we are able to build compact, energy-efficient power supplies with fast dynamic responses uniquely suited to arcing loads.

Viable high-powered switchers

Insulated gate bi-polar transistors (IGBTs) are commercially available today with voltage and current ratings and switching speeds that permit operating at up to 200 kW or more at 20 kHz. At LLNL, we have selected and optimized circuit topologies to exploit the latest in IGBT capabilities for a variety of applications.

We have also developed novel gate drive circuits,

pulse-width-modulation circuits, feedback controllers, snubber networks, inductor and transformer designs, and packaging techniques.

We have developed pulse-width-modulated power supplies for both arcing and nonarcing loads using current-source and voltage-source type circuits. These power supplies typically operate on utility-supplied, three-phase voltage that is rectified and filtered, converted into an alternating voltage of controlled frequency and average value, transformed

into the desired output-voltage level, and then rectified and filtered again.

Fast dynamic performance

Our pulse-width-modulated, switch-mode power supplies have rapid-response feedback loops for regulating output voltage and current.

The current source type also limits the output current during a load arc, terminates the arc in microseconds, and recovers from the arc in milliseconds. The typical dynamic responses for both types of power supplies are at least an order of magnitude faster than those of conventional, phase-controlled, thyristor-type power supplies.

Compact and efficient

The high-switching frequencies of our switch-mode power supplies allow small filter capacitors, inductors, and transformers to be used. As a result, our power supplies are one-half to one-third the size of conventional thyristor-controlled units.

The energy efficiency of our switch-mode power supplies exceeds 90%, which is comparable with the efficiencies of conventional thyristor-controlled units. However, the input harmonics of our supplies are much less, and the input power factor much higher (0.95) than in thyristor-controlled power supplies. This reduces the cost of the input alternating current power distribution system and minimizes power supply interaction.

Availability: We are interested in working with power supply companies to further develop the technology, reduce its cost, and expand its applications as well as in developing demanding and unusual manufacturing applications.

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APPLICATIONS

Low-cost, compact, high-performance power supplies for such applications as:

- Resistance heaters
- Electron-beam guns
- Plasma sputtering systems
- Direct current and high-frequency alternating current magnets
- Electro-chemical processes
- Plasma treatment of pollutants
- Electrostatic precipitators